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CORNING GLASS WORKS
ELECTRO-OPTICS LABORATORY
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IMPROVED SCREEN FOR REAR-PROJECTION VIEWERS

Technical Report No. P-19-29

Date - December 4, 1967

Period Covered - November 10, 1967

to

December 4, 1967

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ABSTRACT

Optical properties have been measured and modulation transfer function data has been obtained for some Corning discrete-particle screens, one of which satisfies the initial contract requirement of $MTF = 0.9$ at 10 cycles/mm.

Unwanted reflections in the MTF measurement system may be contributing to low MTF readings.

Optical properties have been measured for a new series of very thin Corning discrete-particle screens.

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TECHNICAL REPORT NO. 29

I. Modulation Transfer Function Measurements

A. Results

Modulation transfer function data has been obtained for three discrete-particle screens, DP 119, 121 and 126. The MTF curves are shown in Fig. 1, and the measured optical properties of the screens are given in Table I. Note that the thickness given is that of the scattering layer and does not include the substrate. The DP 126 screen has MTF values of 0.89 at 10 cycles/mm and 0.81 at 20 cycles/mm, while the values for the other screens were considerably lower. The DP 126 screen satisfies the initial contract requirement of $MTF = 0.9$ at 10 cycles/mm. The three screens were made of identical materials; the only significant difference between the screens is their thickness. The high MTF of DP 126 is due to its 15-micron thickness as compared to 19 and 26 microns for DP 121 and 119, respectively. The relatively low axial gain values of these screens are due to excessive scattering particle number density and resultant multiple scattering.

B. Discussion

In Technical Report No. 28 it was postulated that a larger decrease in screen diffuse reflectance with a smaller drop in T_{45} is obtained by adding absorbing material in the form of a thin layer on the screen surface, rather than distributing the absorber throughout the screen material, as is commonly done. If the absorbing layer has transmission T , application of the layer to a non-absorbing screen will cause T_{45} to be reduced by

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2

a factor T , but will reduce the diffuse reflectance by a factor T^2 . This is because all of the ambient light must pass through the absorbing layer twice. Experiments have been performed under realistic ambient light conditions which verify this concept.

In our MTF measurements it is necessary to use a high-power microscope objective lens in order to gather enough radiation to permit reliable measurements. Because of the closeness of the lens to the screen (1 to 5 mm), a fraction of the scattered light is reflected by the objective back toward the screen and has the same effect as would ambient light, i.e., the image contrast is degraded, and the amount of degradation depends on the screen diffuse reflectance. Also, at low space frequencies one cycle fills most of the measurement area on the screen, and so the amount of reflected radiation from the objective depends on whether a maximum or a minimum is being measured. At higher space frequency however, many cycles are present on the screen measurement area, and the amount of reflected radiation is independent of the mask position. If an absorbing layer is interposed between the screen being measured and the objective lens, then the effective diffuse reflectance of the screen will be reduced by a factor of T^2 , and the measured image contrast and resulting MTF values should be increased. Experiments are being conducted to determine the magnitude of this effect.

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3

II. Discrete-Particle Screens

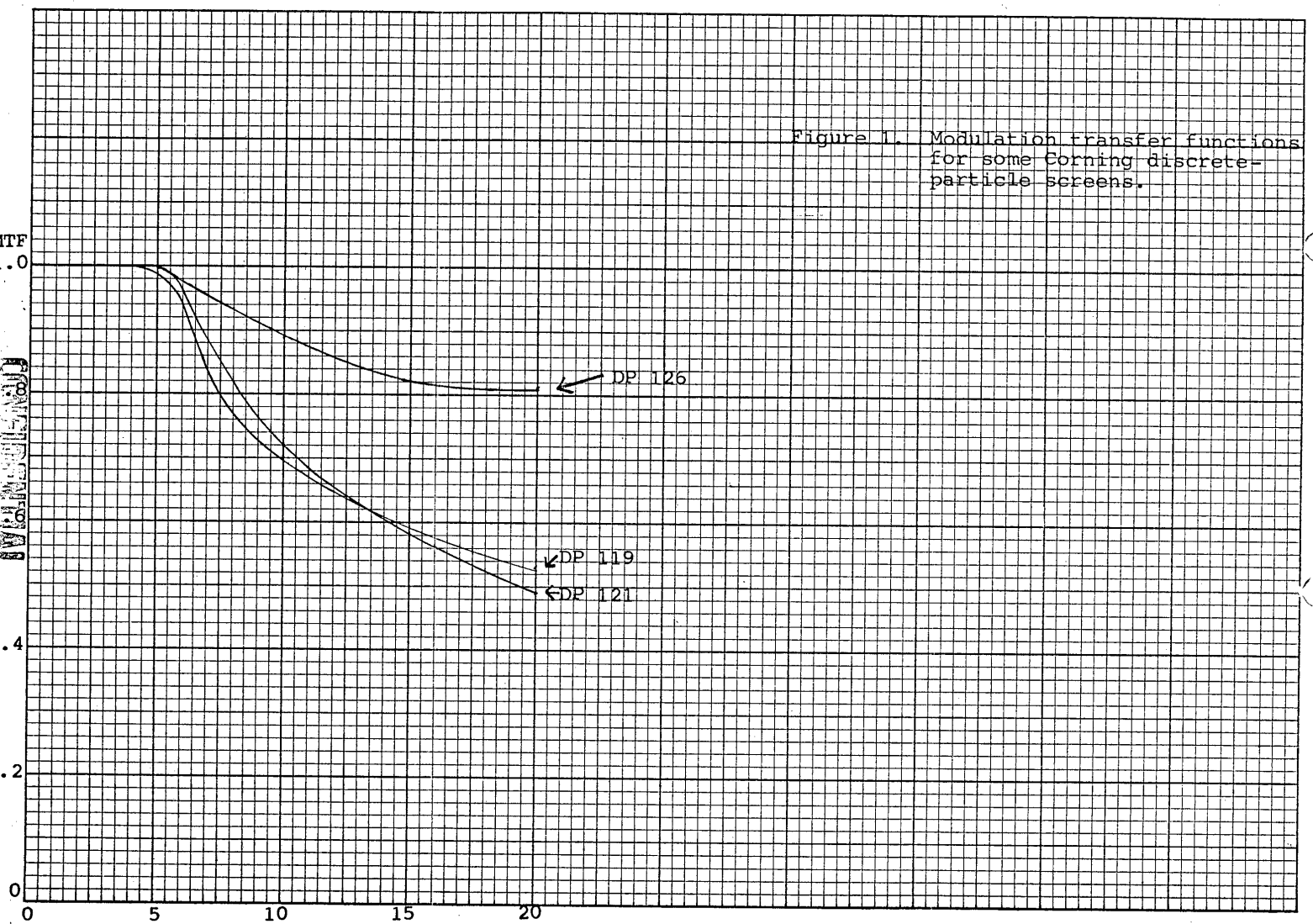
A new series of discrete-particle screens, DP-152 through 163, has been obtained. The optical properties of these screens have been measured and are given in Table I. The axial gain values range from 1.4 to 8.3, and the thicknesses are in the range 5 to 8 microns. MTF curves will be obtained for selected screens, and MTF values are expected to be high because of the higher axial gain values and small thicknesses.

The measured values of T_{45} and R_D for these screens are compared with theoretical values in Figures 2 and 3. Disagreements with theory will be discussed in the final report.

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TABLE I - OPTICAL PROPERTIES OF SOME DISCRETE-PARTICLE SCREENS

| <u>Sample</u> | <u>Axial Gain</u> | <u>T₄₅ (%)</u> | <u>T₉₀ (%)</u> | <u>BV₄₅ (%)</u> | <u>R_D (%)</u> | <u>Thickness</u> |
|---------------|-----------------------|---------------------------|---------------------------|----------------------------|--------------------------|------------------|
| DP 119 | 1.1 | 24 | 43 | ± 13 | 20. | 26 microns |
| DP 121 | 1.4 | 26 | 44 | 22 | 12 | 19 |
| DP 126 | 1.6 | 27 | 44 | 34 | 9 | 15 |
| DP 152 | 1.88 | 29.2 | 50.15 | 36.5 | 13.23 | 7.7 |
| DP 153 | 3.59 | 39.3 | 56.6 | 60.7 | 9.54 | |
| DP 154 | 5.19 | 41.8 | 60.3 | 70.4 | 8.53 | |
| DP 155 | 6.71 | 42.2 | 62.6 | 77.4 | 7.87 | 6.2 |
| DP 156 | 8.32 | 49.1 | 64.6 | 81.3 | 7.13 | |
| DP 157 | 7.67 | 46.7 | 65.4 | 79.2 | 6.32 | 5.4 |
| DP 159 | 1.6 | 26.3 | 46.2 | 31.9 | 11.09 | |
| DP 160 | 1.44 | 24.0 | 41.5 | 31.3 | 9.85 | |
| DP 161 | 6.33 | 41.5 | 58.6 | 76.8 | 7.29 | |
| DP 162 | 4.92 | 36.6 | 51.1 | 74.2 | 6.71 | |
| DP 163 | 4.43 | 33.8 | 46.0 | 74.4 | 6.05 | 5.4 |



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Figure 2. T_{45} vs. axial gain for some Corning discrete-particle screens

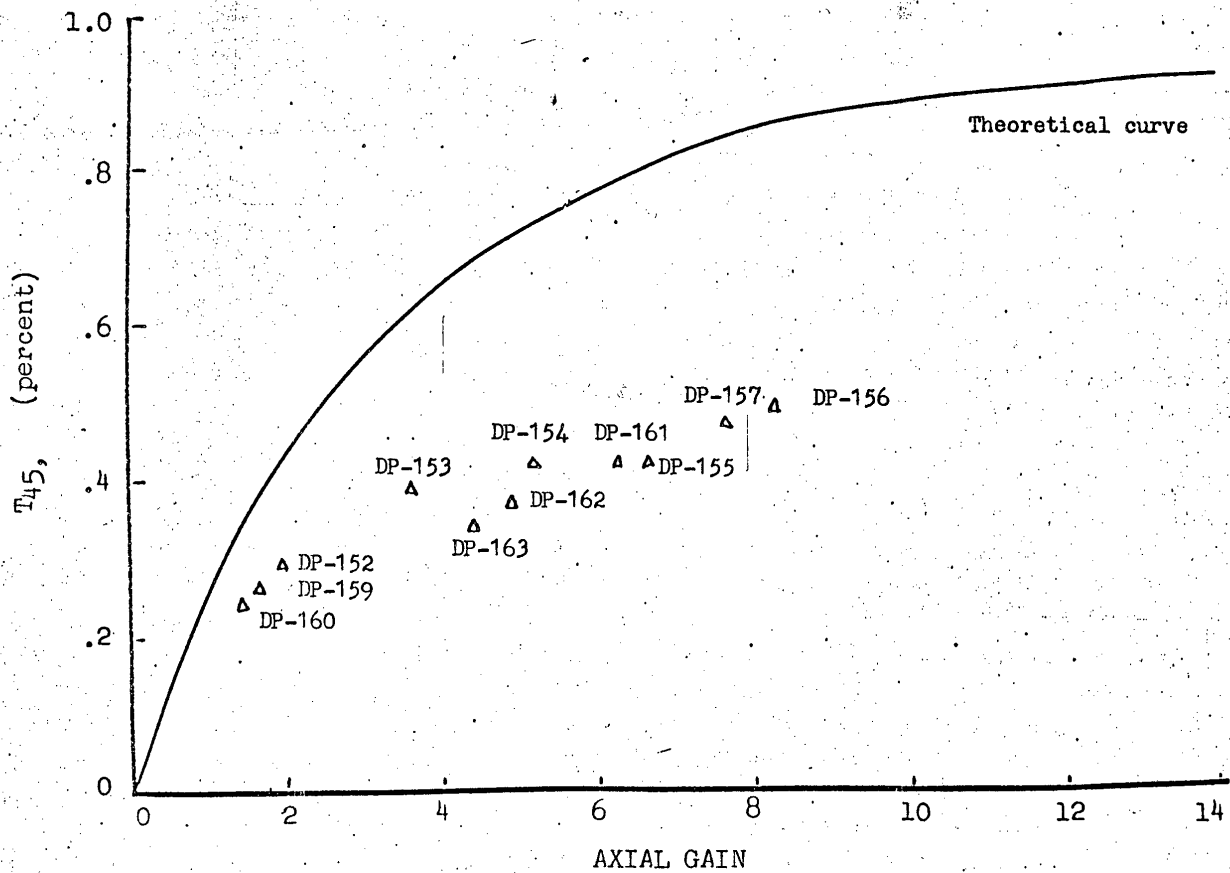


Figure 3. R_D vs. axial gain for some Corning
discrete-particle screens

